MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

Trimester 1 (2016/2017)

EPH7126 – PHOTOVOLTAIC DEVICES AND SYSTEMS

(MEEE)

15 OCTOBER 2016
09.00 am – 12.00 pm
(3 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 5 pages with 4 Questions only.
2. Attempt all **FOUR** questions. The distribution of the marks for each question is given.
3. Please print all your answers in the Answer Booklet provided.

Question 1

(a) (i) Define Air Mass One (AM1).

[1 mark]

(ii) For a vertical structure of height 'h', explain how the air mass is being calculated.

[1 mark]

(iii) What is the most widely used terrestrial standard for calculating air mass distribution?

[3 marks]

(b) Explain Rayleigh scattering and Mie scattering radiation received by earth surface. What are the reasons for such scatterings?

[3 marks]

(c) The typical daily cycle of solar radiation available for a single day is measured by basic instruments (radiometers). Explain the basic differences of THREE (3) different types of radiometers.

[6 marks]

(d) The global radiation at solar noon on a summer solstice in Albuquerque, New Mexico (latitude 35°N), is 60 mW/cm^2. Assume that 30% of this is diffuse radiation that the ground surrounding the module is nonreflecting and the diffuse radiation is uniformly distributed across the sky. Estimate the radiation intensity on a flat surface facing south at an angle of 45° to the horizontal.

[6 marks]

(e) With the aid of block diagram describes different components used in an effective automatic solar submersible pump control system used for irrigation.

[7 marks]

Continued...

Question 2

(a) Briefly describe the followings for a solar cell:

(i) Extrinsic semiconductor

[2 marks]

(ii) Open circuit voltage and Short circuit current

[2 marks]

(iii) Space charge neutrality

[2 marks]

(b) With the aid of a diagram explain the basic structure of a silicon based solar cell. What are the different steps used in the operation of a complete solar cell.

[7 marks]

(c) Light absorption is an important phenomenon in the operation of a solar cell. Explain the physical phenomenon that describes the rate at which light is being absorbed in a solar cell. For a light of frequency 'f', propagating at a velocity 'v' in the x-direction, explain the photon absorption criteria considering the electric field of the propagating light.

[6 marks]

(d) With the aid of relevant diagram, explain Radiative, Non-Radiative and Relaxation recombination process. For a particular sample of semiconductor, the radiative recombination lifetime for minority carriers is calculated as 100 μs, the Auger recombination lifetime as 50 μs, and the lifetime for trapping processes as 10 μs. Assuming that no other process is available for recombination, what is the net lifetime in this material?

[6 marks]

Continued...

Question 3

(a) Explain how the collection probability of generated carriers in a solar cell is estimated.

[2 marks]

(b) Explain how the collection probability and open circuit voltage of a solar cell can be increased by adding necessary Back Surface Field (BSF).

[4 marks]

(c) With the aid of relevant diagram explain the limitation of hetero-junction solar cell.

[4 marks]

(d) Sand to solar cell is commonly used to describe the entire process involved in the fabrication of a complete solar cell from sand. Explain the process involved in the mentioned fabrication process.

[7 marks]

(e) Silicon solar cells of conventional structure are fabricated on a 300 μm thick p-type wafer. Cells with a high recombination back contact gives a short-circuit current of 2.5 A and an open-circuit voltage of 560 mV. Similar cells with a back surface field give a short-circuit current of 2.7 A. The minority carrier diffusion length in the p-type region after processing in all cases is 500 μm. What would be the ideal value of the open-circuit voltage for the cells with a back surface field?

[4 marks]

(f) Solar cell that works by concentrating sunlight can produce significantly higher amount of power from the same dimension of existing solar cell. But such solar cell operation strongly depends on the incident of the light to the certain part of the solar cell. With the aid of diagram briefly explain the mechanism of solar tracking to be used for concentrator solar cell.

[4 marks]

Continued...

Question 4

(a) (i) Define the break-even cost for photovoltaic (PV) technology.

[2 marks]

(ii) Explain Levelized Energy Costs (LEC) in the context of solar photovoltaic technology deployment.

[2 marks]

(b) Explain the economic analysis method of solar photovoltaic based on life cycle costing considering the cost of PV Power mainly depends on the five factors, which are, depreciation cost, annual cost of operations and maintenance, annual loan interest, annual return of capital and annual capacity of generation.

[5 marks]

(c) Explain the condition of Annual Solar Saving (ASS) and Net Present Value (NPV) of the installed solar system. What would be the method to calculate the payback period of the installed system?

[5 marks]

(d) What are the differences among the Standalone, Grid Connected and Hybrid PV Systems? Explain the basic components used to design a Grid Connected PV System. What are the advantages of small units instead of a large unit in the context of Grid Connected PV System?

[8 marks]

(d) What are the failure modes and degradation mechanisms in solar cell which may reduce the power output from or cause the module to fail?

[3 marks]

End of Paper